


Taken from:  
"The Illustrated Encyclopedia  
of the Universe"  
Watson/Guptill

# INTRODUCTION

his book will take you on a journey of exploration from the interior of atoms to the edge of the observable Universe. Along the way we will investigate stars and planets, and the clouds of gas and dust which spawn them; the galaxies of which they are a part; and, finally, the way in which astronomers currently believe the Universe and its contents came into being.

The story of astronomy is in many ways the story of human intellectual advance. Each step in our understanding of the Universe has widened humanity's horizons until, now, we can gaze on the relics of the very event in which the Universe appears to have been created – the Big Bang. In a mere four centuries, a blink of an eye in comparison to our evolutionary history, humans have progressed from assuming that the Earth was the centre of the Universe to recognizing that it is only a modest planet orbiting an average star, the Sun; that the Sun is just one member of a vast congregation known as the Galaxy; that there are countless other galaxies dotted throughout the Universe; and that the space between the galaxies is itself expanding, as though impelled by some enormous explosion over 10 billion years ago. And as astronomers have pushed back the boundaries of the known Universe, so the attitudes and expectations of humanity have grown accordingly. It is often asked why we should spend money on astronomy and space exploration or, indeed, any aspect of scientific research which does not promise an immediate practical benefit. Equally, one might ask what the benefits are of art galleries, museums or concert halls. The answer is, of course, that they are all cultural activities, designed to enrich our experience and help us learn more about ourselves and the world in which we live. Pursuing such activities is what makes us human.

Astronomy and cosmology, in particular, dwell on the greatest philosophical questions of all: How did the Universe begin? Where did we come from? Is there anyone else out there? Our generation is the first to be capable of answering these questions with any certainty, although our answers must always be regarded as open to revision in the light of future findings.

While telescopes have become ever-larger and more sensitive, new designs and manufacturing techniques have kept down their costs, and the use of electronic detectors in place of conventional photography has made them ever-more productive. With the introduction firstly of radio telescopes 50 years ago and now telescopes orbiting above the atmosphere to detect wavelengths that do not penetrate to the surface of the Earth, it has become possible to observe the Universe across the entire electromagnetic spectrum, from the very longest wavelengths (radio) to the shortest (X-rays and gamma rays). The resulting information on celestial objects and the processes at work within them is far more complete than was ever possible when observing in visible light alone.

Closer to home, newspaper headlines warn of issues that are of direct concern. There is much talk of global warming of the Earth, but little understanding of how much of it is due to slight changes in the energy output from the Sun. Until we fully understand the climatic variations



caused by natural effects we cannot properly assess our own impact on our planet. Another area of increasing concern is the threat from comets and asteroids. It is now widely accepted that a mass extinction of living species, most notably the dinosaurs, was triggered 65 million years ago when a large asteroid hit Earth. Smaller impacts, capable of causing localized destruction such as of a city, happen more frequently. Only once we have fully surveyed our interplanetary environment can we assess the full risk we run from such wanderers, and decide how to deal with any of them that may be found to be on a collision course. Asteroids should also be regarded as a potential benefit as well as a risk – many of them may contain raw materials that can be extracted for use on Earth, in place of mining our own planet.

Everyone should have some understanding of the nature of the Universe in which we live. That may seem increasingly difficult as discoveries accumulate at an ever-increasing rate, but in many cases the acquisition of new knowledge helps clarify our picture of the Universe. Quasars, for example, were regarded as inexplicable when discovered in the 1960s. Now they are recognized as being the extremely bright centres of distant galaxies, the most extreme example of a range of activity occurring in the nuclei of galaxies. Pulsars, rapidly flashing radio sources, were another startling finding of the 1960s, but are now known to be one of the end products in the lives of certain stars. Similarly black holes, once the province of theorists and science-fiction writers, are now accepted as real objects, left behind by the deaths of the most massive stars. Enormous black holes are now thought to be the energy sources that heat up gas at the centres of quasars and other active galaxies. Most exciting of all, astronomers are now discovering planetary systems around numerous other stars.

On the other hand, as old mysteries are solved, new ones arise: Why do other planetary systems look different from our own? What is the origin of intense bursts of gamma rays from far off in space detected by orbiting satellites? What is the nature of the invisible dark matter that seems to make up the bulk of the mass of the Universe? Is the expansion of the Universe speeding up as the result of a mysterious cosmological force?

The best that a book such as this can hope to offer is a review of astronomical knowledge, and the physics that underpins it, as it stands at the start of a new century of discovery, certain in the knowledge that, before long, many of our ideas will seem incomplete or in some cases thoroughly naïve. What we have learned about our cosmic environment in the past few centuries, astounding though it is, amounts only to the first steps in a voyage of exploration that will continue as long as the human species remains in existence.

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